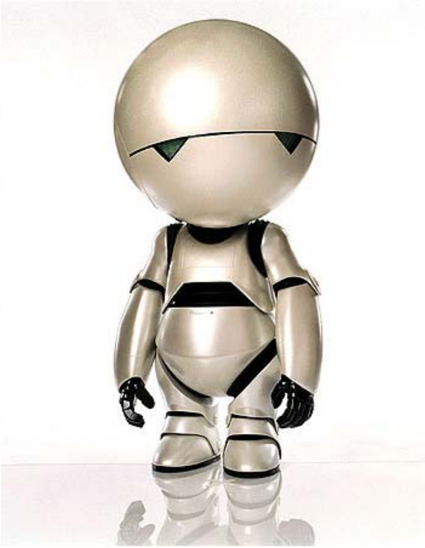
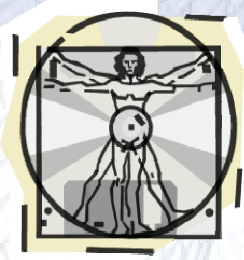
UNIVERSITY OF CALGARY

# Software Agent Models



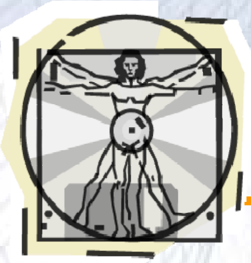
# 1. Agent Models

- There are various ways of modeling and viewing software agents.
- Examples:
  - Computer science models: e.g., indeterministic push-down automaton
  - Software engineering models: based on the object-agent analogy [Jennings and Wooldridge's works]
  - Interaction models: subsystems; software components; or packages



# 1. Agent – Object Analogy

- Object-agent analogy can potentially be misinterpreted and can lead to overselling the agent-based approaches.
- Because *object* is a component level concept and *agent* is an application level one.
- Similarity of *agent-oriented* and *object-oriented* terms should not imply that agent and object are similar entities.

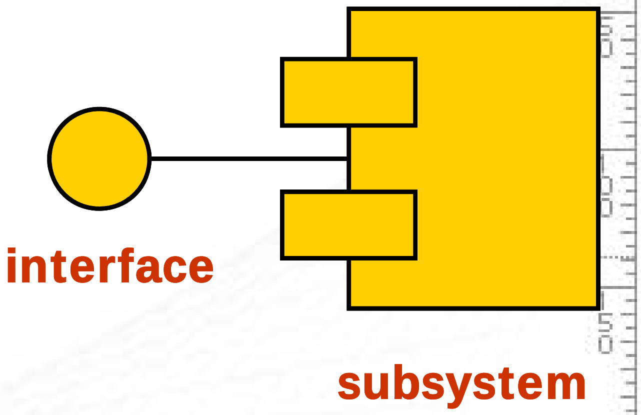


# 1. Agent – Object Analogy (contd.)

- **Object-oriented software engineering:** engineering a computer program based on objects which are its building block and we use object-oriented methodologies during software analysis and design. ← **building software with objects**
- **Agent-oriented software engineering:** development of a computer program that has properties of an agent and it involves concepts like knowledgeability, autonomy and interactivity. We use agent development methodologies for analysis and design and we use objects to implement them. ← **building software with agent capabilities**

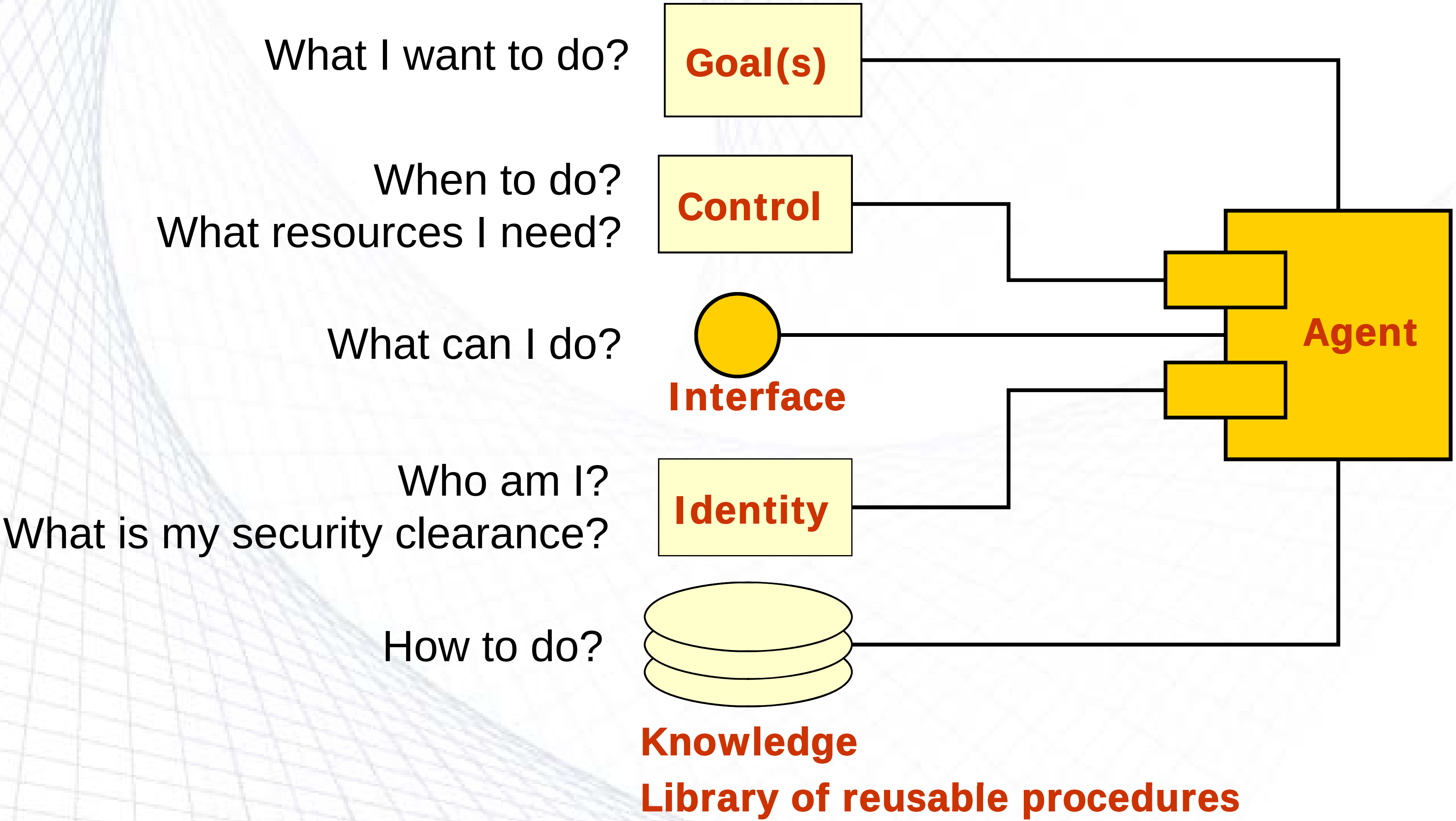
# 2. Subsystem Analogy

- Modeling agents as *software components*, i.e., a subsystem with complete encapsulation of its behavior that has an attribute, called interface (i.e., what they can do). The component can be accessed through its interface.
- An agents requiring services of another agent may consult directory and naming services (i.e., agent yellow pages) and use the services that the agent offers by adhering to the rules specified in the interface document for that agent.



Experience shows that this limits the scope of the software agents, in the sense that autonomy, proactiveness and interactivity may be compromised.

# Enhanced Interaction Model



# Enhanced Model: Attributes

- Attributes:
- Interface (I) (i.e., what the agent can do?)
- Goal list (G) (i.e., what the agent wants to do?)
- Knowledge (K) (i.e., how to do?)
- Control (C) (when to do?)
- Identity (Id) (whom to contact?)

# Enhanced Model: Attributes

- I-G-K-C-Id attributes can be declared ***public***, ***private*** or ***protected***
- ***Public:*** means that the attribute is accessible and readable by all the other agents
- ***Protected:*** means that the attributes are visible only to a certain group of agents
- ***Private:*** indicates that the attributes are not visible externally
- Combination of the attributes and their states lead to various interaction scenarios
- Each interaction scenario has certain properties and satisfying those properties requires implementation of certain reasoning and decision making mechanisms

# Interaction Scenarios

- Using the enhanced model, each agent can decide upon the next task to accomplish using the current I-G-K-C-Id list: interfaces, goals, knowledge, identity and thread of control of *self* and the *other* agents with whom interacting.

# Cooperation & Coordination

| *Cooperation & Coordination Scenario* | | |
|---|---|---|
| ***Attribute*** | ***Visibility*** | ***Requirements*** |
| Goal (G) | Public | Necessary requirement |
| Knowledge (K) | Public | |
| Interface (I) | Public | Full automation and bilateral service |
| | Protected or Private | Unilateral service only (publish/subscribe) |
| Control (C) | Public | Sync and/or concurrency |
| | Protected or Private | No sync and/or concurrency |
| Identity (Id) | Public | Full communication and bilateral service |
| | Protected or Private | Unilateral service only |

***Requirements:***

- Knowledge sharing and semantics level message passing methods are needed.
- Additional decision making and/or reasoning methods are not needed.
- Uncertainty management techniques are not needed.

# Competition

| *Loose Competition Scenario* | | |
|---|---|---|
| ***Attribute*** | ***Visibility*** | ***Requirements*** |
| Goal (G) | Public | Necessary requirement |
| Knowledge (K) | Private | |
| Interface (I) | Public | Comparison of services |
| | Protected or Private | Encapsulate own |
| Control (C) | Public | Strategic or dynamic game |
| | Protected or Private | Strategic game only |
| Identity (Id) | Public | Role changing is impossible |
| | Protected or Private | Role changing possible |

***Requirements:***

- Ability to gather and interpret signals indirectly.
- Additional decision making and/or reasoning methods, based on certainty and uncertainty, such as game and utility theory are needed.

# Case Studies

- When an agent interacts with the other agents, it is assumed that it has full knowledge of the state of its own I-G-K-C-Id attributes. However, the status for the other agent may be:
  - ***Case 1:*** fully known
  - ***Case 2:*** unknown but the probability distribution over the triple states is known
  - ***Case 3:*** unknown and the probability distribution over the triple states are unknown

# Case 1

- Agent_1 knows exactly what the state of the attributes of the Agent_2 is.
- In this case, decision making for Agent_1 is straightforward: Agent_1 can usually select its strategy based on maximum expected utility.

# Case 2

- Agent_1 does not know the exact states of the attributes of Agent_2 but it has a probability distribution over the states of Agent_2.
- In this case, Agent_1 treats the known probability distribution as its “belief” and selects the strategy which maximizes its expected utility but broaden the notion of value to reflect the agent’s attitude towards risk.

# Case 3

- Agent_1 doesn’t know anything about the state of the attributes of Agent_2 except for that it is public or private or protected.
- According to cognitive psychology, when probability distribution is not known, people evaluate belief based on *degree of comfort* (i.e., selecting the alternative that needs the least effort) or *degree of optimism* (i.e., selecting the alternative that we think is the most fit).
- Agent_1 needs a belief assignment method which reflects agent’s degree of optimism.